resourceful. naturally.
engineering and environmental consultants

BARR

GENERAL TRANSMITTAL

To:	Darren Gietzen and Tom Moe Minnesota Ore Operations Minntac Plant 8819 Old Hwy 169 PO Box 471 Mountain Iron, MN 55768	**Date:** **Project:** **Re:**	May 8, 2015 23/69-1607.00 Design alternative evaluation technical memorandum for the Minntac tailings basin west seepage collection

☐ **Enclosed**	☑ **We are sending:**	☐ **We are returning:**
☑ Correspondence	☐ Report	☑ Other
☐ Specifications	☐ Proposal	

Description:
Enclosed, please find 3 copies of the technical memorandum and attachments regarding the design alternative evaluation for the Minntac tailing basin west seepage collection.

These are transmitted:	☑ For your use	☐ For review and comment
☐ For approval	☐ For construction	☐ Other
☐ For bid	☐ As requested	

Remarks:

Sent by: Jon Minne

c: file

Technical Memorandum

To: Darren Gietzen, Tom Moe, U. S. Steel
From: Jon Minne, P.E., Vicki Hagberg, P.E., Barr Engineering
Subject: Design alternative evaluation for Minntac tailing basin west seepage collection
Date: May 8, 2015
Project: Barr Project No. 23691607.00
c: file

Background

Ten surface water seeps have been identified at U. S. Steel - Minntac's tailings basin west perimeter dam along the downstream toe that discharges to nearby surface waters at an average rate of approximately 1,600 gpm of water. The surface water discharged from the seeps channelizes and flows to adjacent wetlands located in the Upper Dark River watershed. Analysis of seepage water quality indicates that certain characteristics (hardness, total dissolved solids, specific conductance, alkalinity, and possibly sulfate) do not meet Minnesota Polution Control Agency (MPCA) surface water standards. Minntac is required by the MPCA to collect the surface seepage near the west perimeter dam toe and return it to the basin, preventing it from reaching nearby surface waters.

U. S. Steel is currently operating a seepage collection system on the east side of the Minntac tailings basin comprised of catch basins with interconnecting gravity piping draining to a pump station, which pumps the collected seep water back into the tailings basin. This system is currently functioning as designed. A similar seepage collection system is proposed for the west side of the tailings basin.

Hatch Ltd. (Hatch, *2014*) prepared a conceptual seepage collection design for the west perimeter dam that would result in approximately 25 acres of wetland impacts. U. S. Steel would like to explore other design ideas with the goal of minimizing the wetland impacts while capturing all identified surface water seeps on the west side of the tailings basin and demonstrating those efforts during the wetland permitting phase of the project.

Barr identified 18 options that could possibly capture or eliminate surface seepage discharge along the Minntac tailings basin west perimeter dam. The options focused on various methods for collecting surface seepage, reducing seepage quantity, or preventing seepage from exiting the tailings basin. These options were reviewed with U. S. Steel in a meeting with Darren Gietzen and Tom Moe on March 3, 2015, using an evaluation matrix developed for this project. The evaluation included defining and ranking criteria which was used to compare the options. The top-ranked critieria used to review these options included:

- effectiveness of surface seepagecapture or elimination
- impacts on wetlands
- maintenance requirements
- cost
- time to construct

After completing this detailed review of the identified options, three were selected for further review as presented in this memorandum.

Purpose and Scope

The purpose of this technical memorandum is to summarize the three best options identified during the option evaluation phase of the project. Each option was identified as effectively capturing or eliminating the ten identified surface seeps along the west side of the tailings basin from discharging to adjacent surface waters. Each of the three options will be described, and the benefits, negative features, and risks of each system will be discussed.

The memo includes a review of the existing conditions, options review, environmental considerations, summary, list of attachments, and reference citation.

Existing Conditions

A total of 10 seeps were identified along the toe of the west perimeter dam of Minntac's tailings basin during a perimeter dike surface seepage survey completed in November and December 2012. The locations of the identified surface seeps are shown in Figure 1. U. S. Steel measured seepage flow rates at each of the seeps over three monitoring events in 2012 and 2014. Table 1 summarizes the measured flow rates for each identified seep.

Table 1 Historical measured seepage flow rates

Seep	Seepage Flow in gallons per minute			
	November-December 2012	July 2014	October 2014	Average
C	603.2	1363.0	--*	983
A	57.7	12.1	11.3	27
B	10.8	--*	--*	11
D	27.9	37.0	47.7	38
E	204.1	259.6	153.4	206
F	416.3	320.8	373.9	370
G	98.7	76.3	85.3	87
H	30.7	44.9	50.3	42
I	43.1	101.4	62.4	69
J	159.9	61.9	71.8	98
*seepage not measured during this monitoring event				

The tailing basin west perimeter dam is constructed of two coarse-tailings outer dams with an inner fine-tailing cutoff. The coarse tailings dams were constructed in approximate 10-foot lifts, and a 10-foot-deep by approximately 100-ft wide key was excavated between them into the native soils (Dames & Moore, 1992). Fine tailings were sequentially spiggoted into the trench between the coarse tailings dams creating a cutoff. The native soils underlying the perimeter dam have been characterized in a series of geotechnical investigations completed in 1981 (Soil Testing Services of Minnesota, Inc., *1981*), 1992 (Dames & Moore, 1992), and 2011 (Hatch Ltd., *2011*). The foundation soils can be generally characterized as sand deposits with frequent cobbles and boulders, occasional clay lenses, and pockets of peat and organic soils in wetlands.

Peat and topsoil were encountered in boreholes located to the west of the toe of the west perimeter dam, consistent with the presence of undisturbed wetland and upland features outside of the basin footprint. Peat was encountered in select boreholes completed through the tailings basin dams; however, the majority of the boreholes completed through the dam did not encounter peat, indicating that the most of the organic material was removed from the dam foundation prior to fill placement. Sandy soils, often with apparent cobbles and boulders, were observed underlying dam fill and peat layers. A combination of sand till with apparent boulders, cobbles, and sandy alluvial deposits with gravel were encountered at all of the boreholes from the available geotechnical investigations. Some borings also indicated presense of alluvial clay lenses within sandy alluvial deposits. Clay was not encountered in all boreholes, and lenses of clay were not found to be continuous beneath the west perimeter dam alignment or at the toe of the dam. Perched or confined aquifers are not anticipated to be present at this site based on review of the boring logs. Depth to granite bedrock was recorded as varying from less than 20 feet below native ground surface (not including dam fill) to over 120 feet below native ground surface.

Barr conducted an initial site visit on Feburary 16, 2015, and a follow-up visit on March 20, 2015, to observe surface seepage before and after snow melt. Surface seepage and resulting open surface water runoff was visible during the February 2015 visit when most other surface waters in the area were frozen. In addition, water was observed to be seeping through the coarse tailings interior dams into the shallow swale located between the perimeter dam and the interior fine tailings depositional cells. The water flow through the swale was also open, which is likely related to the temperature of the fine-tailings flow from the plant being significantly above freezing. The observation of open water surface seeps downstream of the dam during freezing conditions indicates that the surface seeps likely originate from tailings basin water and that the seepage is being conveyed primarily through the sandy soils underlying the perimeter dam.

Most of the seepage was observed downstream of the perimeter dam. Some seepage was observed at the very toe of the perimeter dam. This observation indicates that the fine-tailings cutoff is effective at reducing the phreatic surface within the perimeter dam. If the dam was constructed solely of coarse tailings, seepage would be expected to daylight at approximately one-third of the height of the embankment. Observation of surface seeps downstream of the embankment is likely a result of the fine-tailing cutoff not extending all the way to the low-permeability bedrock. It is also likely that seepage is reduced as a result of the cutoff, but it is not entirely eliminated since there are high-permeability sands underlying the cutoff and in hydrologic contact with the tailings basin waters.

Minntac has provided recent aeriel topography, previous geotechnical data, dam stability reports, previous design work, and wetland delineations for the area along the west perimeter dam for use in this review.

Options Review

Collect and Pumpback

This option consists of preparing a design similar to Hatch's conceptual design of surface seepage collection and pumpback with a design focus to minimize wetland impacts.

The design concept we arrived at is shown on the attached Figures 1A through 4. Figures 1A and 1B show the area by Seeps A, B, and C. Sheet pile will be used along the western edge of the Poleline Road to block off the existing surface seeps, while a combination of proposed culverts and existing grades will direct the flow north along the east side of the Poleline Road to a lift station. The water will then be pumped over the perimeter dam via forcemain and discharge into the existing drainage swale. Access to the drainage infrastructure and pump stations would be from the existing poleline road.

Figure 2 shows the area along Seeps D, E, F, and G. Sheet pile will be used to isolate portions of existing wetlands that will be used to collect and convey water via existing grades, proposed ditching, and proposed culverts to a lift station. The water will then be pumped over the perimeter dam via a forcemain and discharged into the existing drainage swale. Access to the drainage infrastructure and pump stations would be from the existing poleline road and existing perimeter dam access roads.

Figure 3 shows the area along Seeps H and I. Sheet pile will be used to isolate portions of existing wetlands that will be used to collect and convey water via proposed culverts to a lift station. The water will then be pumped over the perimeter dam via a forcemain and discharged into the existing drainage swale. Access to the drainage infrastructure and pump stations would be from a new access road originating from the perimeter dam.

Figure 4 shows the area along Seep J. Sheet pile will be used to cutoff the open water body from downstream wetlands along the existing beaver dam. The water level would be held at its current elevation and controlled by the inlet elevation into the pump station. Access to the drainage infrastructure and pump stations would be from a new access road originating from the perimeter dam

The anticipated wetland impacts for this option are highlighted on each figure. A description of the basis for the quantity of wetland impacts for each figure is included in the environmental considerations section of this memorandum. The wetlands outside of the sheet pile will not be directly impacted as a result because the sheet pile will be driven into the native soils only far enough to minimize back draining the wetland into the collection system while allowing existing groundwater flows to contribute to the wetland hydrology. This method was used on the east side collection system resulting in no impact to the wetlands outside of the sheet pile per U. S. Steel. The proposed design will result in approximately 5.15 acres of permanent, direct, wetland impacts and 0.60 acres of tempoarary wetland impacts.

Tasks to further develop this option include additional soils data collection, drainage path topography, design calculations, sheet pile sizing, culvert and ditch sizing, pipe and structure elevations, pump sizing, power connections, access road grading, and energy dissipation.

Hydromill Seepage Cutoff

This option consists of constructing a seepage cutoff through the perimeter dam and underlying foundation soils. Seepage cutoffs consist of a low-permeability barrier installed through more permeable soils, significantly reducing or preventing groundwater flow in the area of the cutoff, thus preventing surface seepage. Options for seepage cutoffs include sheet piles, deep soil mixing (insitu mixing of grout with soils to reduce permeability), grout curtains (grout injection to reduce soil permeability), hydromill systems (excavation of soils and replacement with a low-permeability grout), and biosealing (injection of biological organisms to reduce soil permeability), or a combination of these methods. Hydromill was selected as the most suitable cutoff option for this site because of its ability to be constructed through soils with boulders and keyed into the underlying low-permeability bedrock. Other options have a higher risk of only partial groundwater cutoff, which may only result in a reduction in seepage instead of more complete surface seepage source cutoff.

The design concept we arrived at is shown on the attached Figures 5 through 8. Figures 5 and 6 show the area by Seeps A, B, and C. A seepage cutoff system would be installed within the perimeter dam along the entire south side of Cell-D1 to help eliminate Seep C and prevent water from seeping through the south dam when discharging tailings into Cell-D1. Shorter seepage cutoff systems approximately 200 feet in length would be installed in the Poleline Road near Seeps A and B as shown on Figure 6. The cutoff systems would be extended down to the bedrock to minimize the chances of seeps reforming at these locations. Risks with this option include migration of seeps around the cutoff reemerging in new locations, changes in downstream groundwater hydrology, and tailing basin water balance. The impact levels of these risks are unknown at this time.

Figure 7 shows the area along Seeps D,E,Fand G. A seepage cutoff system would be installed within the outer perimeter dam from the upland south of Seep D to upland north of Seep G. The extended length of the cutoff system helps minimize the risk of seeps moving laterally and occurring in wetland areas beyond its edges. The cutoff system would also be extended down into the bedrock to further minimize the chances of seeps reforming at these locations.

Figure 8 shows the area along Seeps H, I, and J. A seepage collection system would be installed within the outer perimeter dam extending from high land south of Seep H to high land east of Seep J. The extended, continuous length of the cutoff system would help minimize the risk of seeps moving laterally and occurring in wetland areas beyond its edges. The cutoff system would also be extended down into the bedrock to further minimize the chances of seeps reforming at these locations.

This option would not impact wetlands during construction; however, while there are no direct construction related wetland impacts, it is anticipated that construction of a seepage cutoff could significantly reduce the groundwater level in adjacent wetlands and in the Dark River. Minntac's tailings basin is believed to charge the adjacent water table currently, supporting the Upper Dark River watershed. Installation of a seepage cutoff would reduce groundwater flow through the perimeter dam foundation soils, possibly causing secondary wetland impacts of significant scale.

Combination of Collect and Pumpback and Seepage Cutoff

This option consists of constructing a combination of the collect and pumpback option with the seepage cutoff option as described below.

The design concept we arrived at is shown on the aforementioned figures attached. Seeps A, B, and C could be contained using the collect/pumpback method described in Option 1 and shown on Figures 1A and 1B. This option would limit wetland impacts, manage and contain variable flows seeping through the south dam, and contain the three seeps. Additionally, the shorter lengths of the proposed seepage cutoffs at Seeps A and B may prove impractical for the use of certain equipment such as a hydromill. Finally, the proposed lift station is located close to an existing power source.

Seeps D, E, F, G, H, I, and J could be contained using the seepage cutoff method described in Option 2 and shown on Figure 7 and 8. Due to the unkown risks with the cutoff option described previously, this option wan not developed further.

Environmental Considerations

The primary environmental consideration for this review is capturing or eliminating the surface seepage along the western perimeter dam toe and minimizing wetland impacts. The collect and pumpback option will have direct wetland impacts without anticipated indirect impacts. While the cut-off method will not have direct wetland impacts to construct, it is anticipated that this option could have significant indirect wetland impacts as compared to the collect and pumpback option. The cutoff option also poses post installation risks of unkown magnitude as noted above.

The collect and pumpback design concept prepared for this memorandum minimizes direct and indirect wetland impacts to the practical extent possible to construct and maintain the system with the current available data.

The anticipated wetland impacts in subcatchement 1 will consist of temporary impacts during the installation of sheet pile fill by Seep C, this fill would be removed upon completion of the sheetpile installation. The drainage path will be designed so the all the current wetland water levels inthis subcatchement area are not significantly altered from their current condition as a result of the project.

The anticipated wetland impacts in subcatchment 2 will consist of the following permanent impacts. The sheetpile installation fill at Seep D will not be removed for maintenance access to the new downstream ditch. This new ditch will be designed so the current upstream wetland water level is not significantly altered. The small wetland along the ditcline will be impacted to prevent the ditch water from discharging into the nearby open water wetland. The wetlands from the ditch discharge to Seep F will be permanently impacted by either wetland water level changes, sheet pile fill or maintance access construction. A small amount of fill to install sheet pile north of Seep F will be needed to provide cutoff for Seep D source water. A small swale east of Seep D is provided to minimize wetland water level changes in the wetland to the North of Seep D.

The anticipated wetland impacts in subcatchment 3 will consist of permanent wetland impacts by either wetland water level changes, sheet pile fill or maintance access construction.

The anticipated wetland impacts in subcatechement 4 will consist of permanent wetland impacts to install and maintain the sheetpile along the existing beaver dam (sheet pile section running in north to south direction). This section will be used to control the existing upstream water level in the wetland. The section of wetland southeast of the beaver dam adjacent to the permiter dam toe will be permanently impacted by by either wetland water level changes, sheet pile fill or maintance access construction.

Other environmental impacts associated with these options were not defined with this review.

Summary

The evaluation included defining and ranking criteria which was used to compare the options. The top-ranked critieria used to review these options included:

- effectiveness of surface seepage capture or elimination
- impacts on wetlands
- maintenance requirements
- cost
- time to construct

Because of the unknown potential secondary impact to adjacent wetlands, tailings basin water balance, and possible water augmentation requirements, Minntac has indicated that the risk is too high using a hydromill cuttoff and is not currently under further consideration for addressing the existing surface seepage along the tailings basin west perimeter dam.

The collect and pumpback option will minimizes the wetland impacts to the extent practical to install and maintain the system and is similar to the existing collection system on the east side of the tiailing basin. The will beapproximately 5.15 acres of direct wetland impacts, 0.60 acres of tempoarary wetland impacts , resulting in a 79% reduction from the previous collect and pumpback design. This option will consist of constructing approximately 7,440 linear feet of sheet pile, four pump stations, drainage piping, and ditches providing seepage collection over approximately 10,400 linear feet of the perimeter dam toe.

Attachments

Figure 1 – MinnTac Tailing Basin, West Perimeter Dam Seep Locations

Option 1 Conceptual Design Figures 1A to 4

Option 2 Conceptual Design Drawings 5 to 8

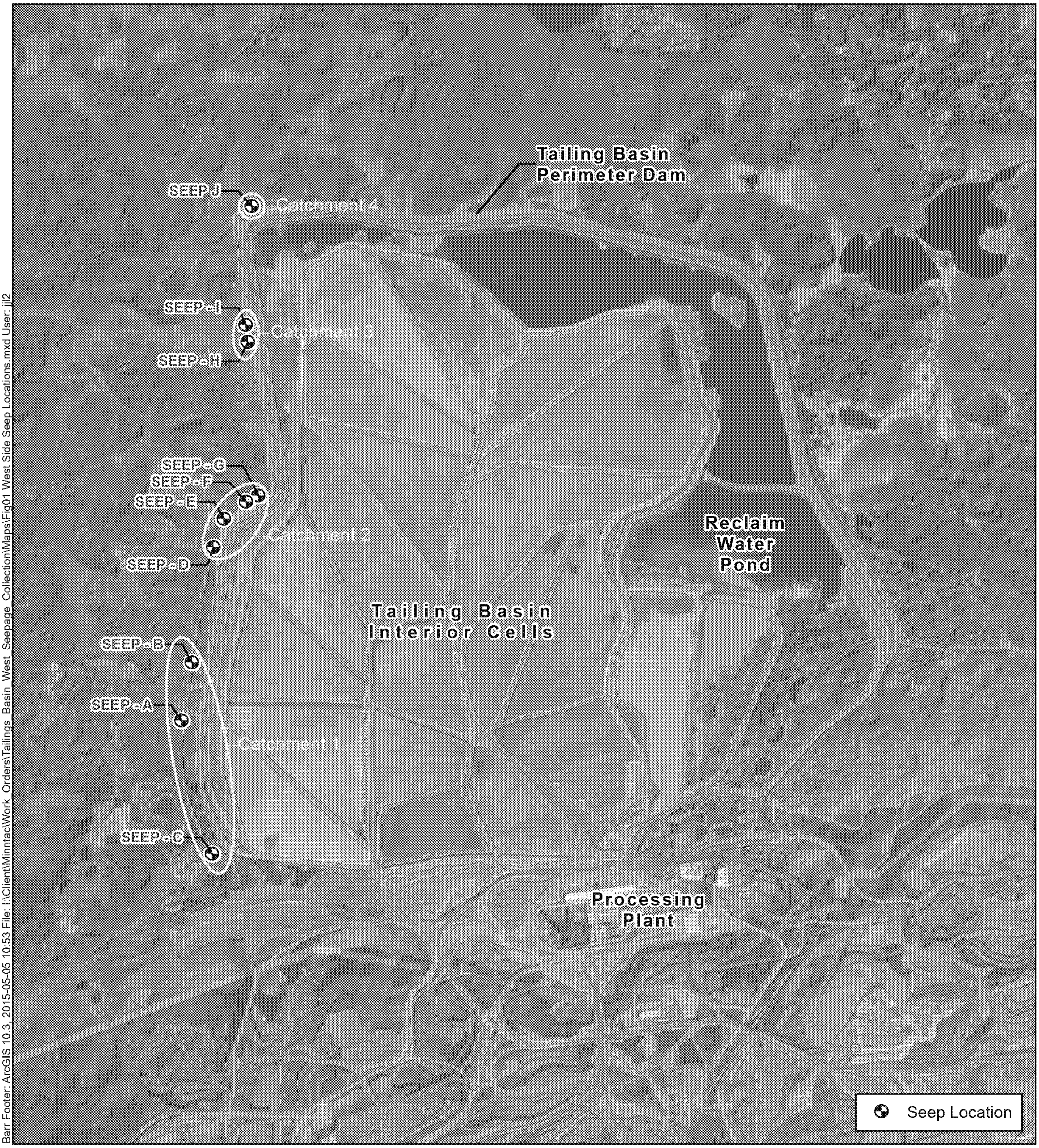
References

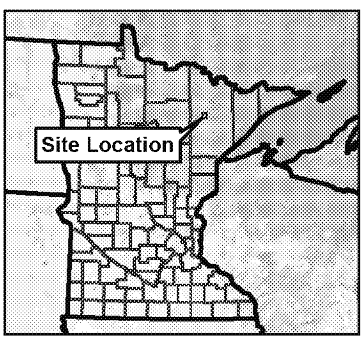
Dames & Moore. *Dike Stability Assessment, MinnTac Tailing Pond Management Plan, Draft Report,* s.l. : Job No. 02556-218. 1992.

Hatch Ltd. *Minntac Western Seepage Collection System, Phase 2 Report. U. S. Steel Corporation - Minnesota Ore Operations,* s.l. : March 11, 2014. Revision C.

Hatch Ltd. *Geotechnical Investigation Report, 2011.* s.l. : December 12, 2011. Revision B.

Soil Testing Services of Minnesota, Inc. *Installation of groundwater monitoring observation wells in the vicinity of the Minntac Tailings Basin at the United States Steel Corporation Facilities in Mount Iron, Minnesota*. Minneapolis, MN : Soil Testing Services of Minnesota, INC., August 27, 1981. STS Job Number V-92638.





N

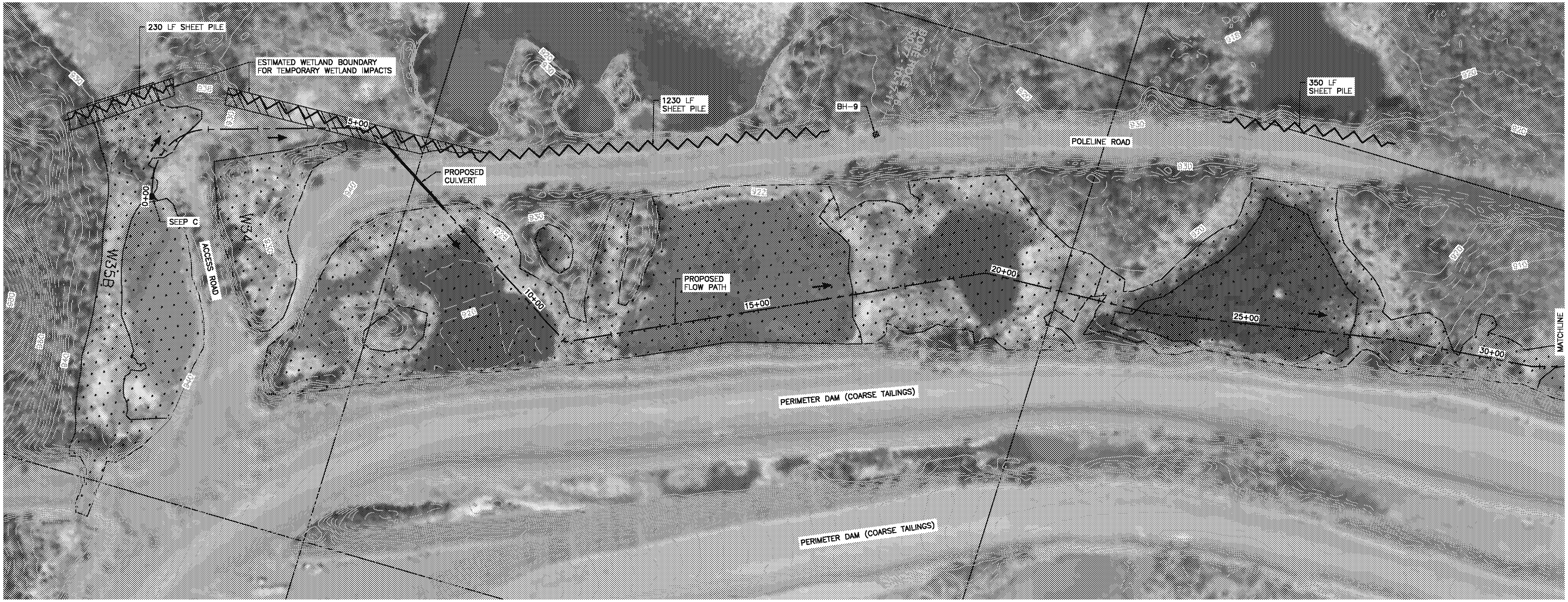
4,000 2,000 0 4,000

Feet

Imagery: FSA (2013)

Figure 1

WEST SIDE
SEEP LOCATIONS
U. S. Steel - Minntac
St. Louis County, MN



LEGEND

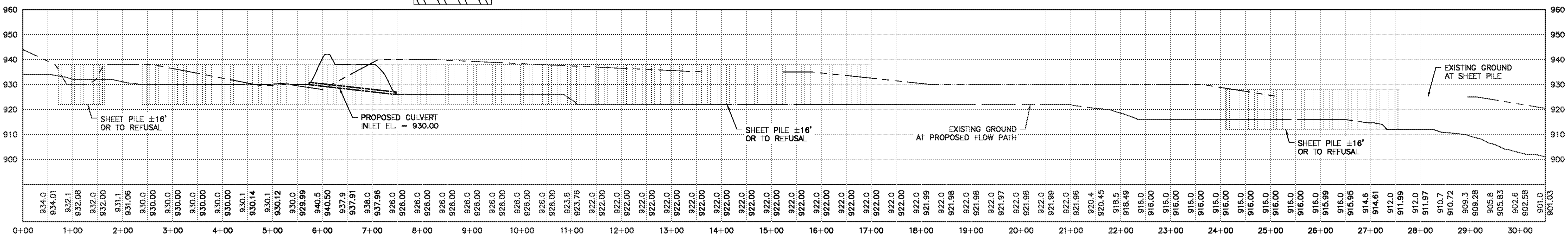
- PROPOSED SHEET PILE
- FM — PROPOSED FORCEMAIN
- WETLAND IMPACT AREA

0 100 200
SCALE IN FEET

PERMANENT WETLAND IMPACTS = 0.00 ACRES

TEMPORARY FOR CONSTRUCTION = 0.55 ACRES

NOTES:
1. WETLAND BOUNDARIES ARE PER DELINEATIONS PROVIDED BY MINNTAC FROM 2014 DELINEATION REPORT
2. SUBSURFACE GEOTECHNICAL INFORMATION PROVIDED BY MINNTAC FROM HISTORICAL RECORDS
3. TOPOGRAPHY PROVIDED BY MINNTAC



0 100 200
SCALE IN FEET
HORIZONTAL

0 20 40
SCALE IN FEET
VERTICAL

ISSUED FOR REVIEW

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION
C	VJS	JMM3	JMM3	5/13/15	ISSUED FOR REVIEW-UPDATED WITH WETLAND ID NUMBERS
B	VJS	JMM3	JMM3	5/08/15	ISSUED FOR REVIEW-UPDATED PER MINNTAC COMMENTS
A	VJS	JMM3	JMM3	4/16/15	ISSUED FOR REVIEW

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

PRINTED NAME ____

SIGNATURE ____

DATE ____ LICENSE # ____

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT	4/16	5/08	5/13				
BID							
CONSTRUCTION							
	DATE RELEASED						

BARR
Corporate Headquarters: Minneapolis, Minnesota
Ph: 1-800-632-2277

Project Office:
BARR ENGINEERING CO.
3128 14TH AVENUE EAST
HIBBING, MN 55746
Ph: 1-800-225-1966
Fax: (218) 262-3460
www.barr.com

Scale	AS SHOWN
Date	03/10/15
Drawn	VJS
Checked	JMM3
Designed	VJS
Approved	JMM3

MINNTAC
MOUNTAIN IRON, MINNESOTA

MINNTAC TAILING BASIN
WEST SEEPAGE COLLECTION

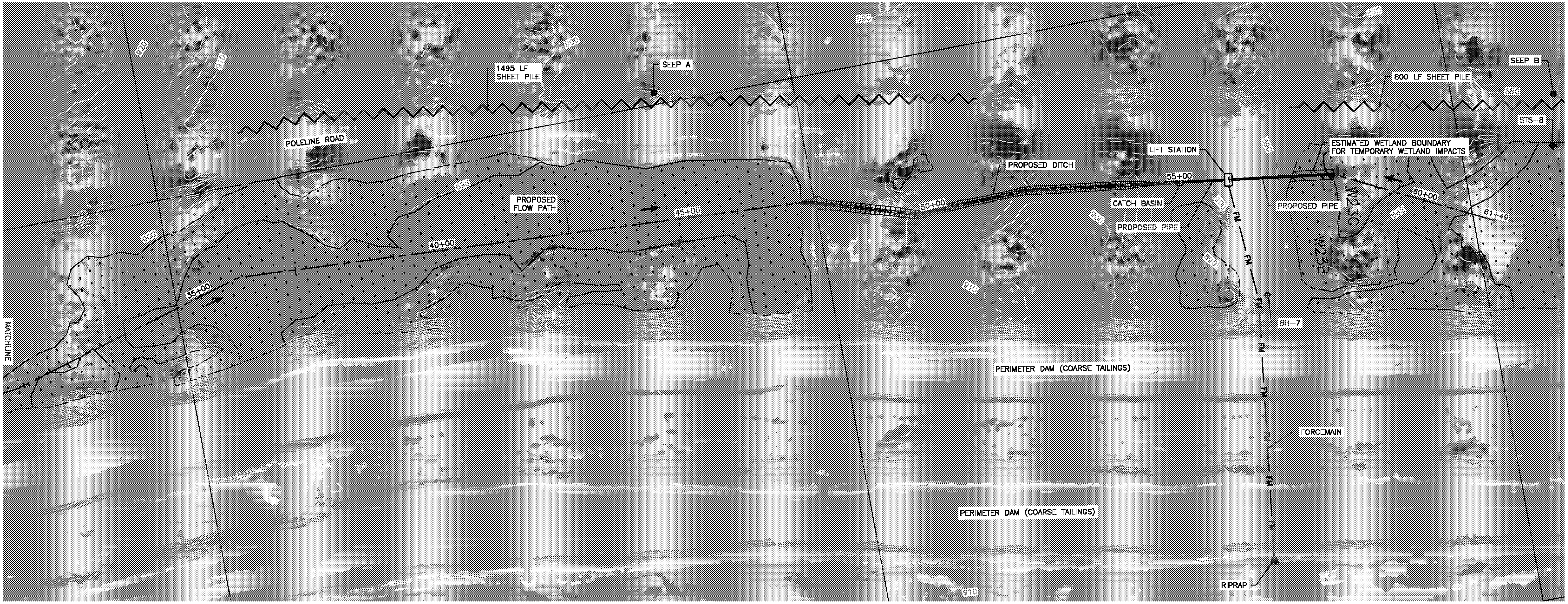
OPTION 1 – CATCHMENT 1
COLLECT/PUMP BACK – MIN WETLAND IMPACT

BARR PROJECT No. 23/69-1607

CLIENT PROJECT No.

DWG. No. FIG 1A

REV. No. C



LEGEND

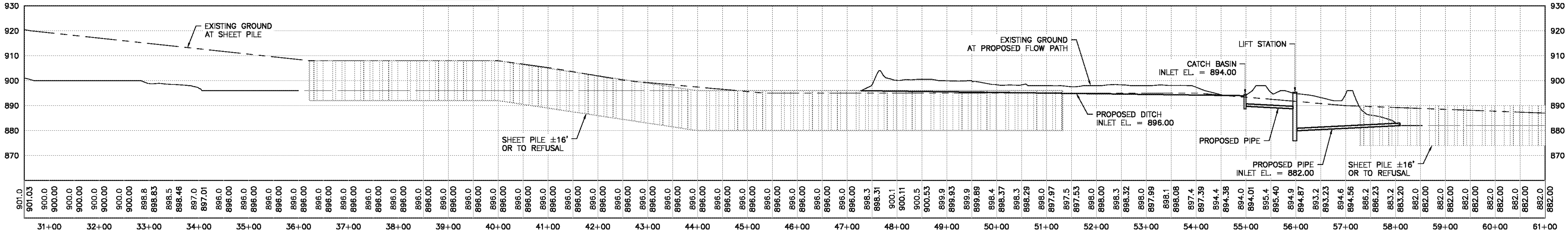
- PROPOSED SHEET PILE
- FM — PROPOSED FORCEMAIN
- WETLAND IMPACT AREA

0 100 200
SCALE IN FEET

PERMANENT WETLAND IMPACTS = 0.00 ACRES

TEMPORARY FOR CONSTRUCTION = 0.05 ACRES

NOTES:
1. WETLAND BOUNDARIES ARE PER DELINEATIONS PROVIDED BY MINNTAC FROM 2014 DELINEATION REPORT
2. SUBSURFACE GEOTECHNICAL INFORMATION PROVIDED BY MINNTAC FROM HISTORICAL RECORDS
3. TOPOGRAPHY PROVIDED BY MINNTAC



0 100 200
SCALE IN FEET
HORIZONTAL

0 20 40
SCALE IN FEET
VERTICAL

ISSUED FOR REVIEW

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION
C	VJS	JMM3	JMM3	5/13/15	ISSUED FOR REVIEW-UPDATED WITH WETLAND ID NUMBERS
B	VJS	JMM3	JMM3	5/08/15	ISSUED FOR REVIEW-UPDATED PER MINNTAC COMMENTS
A	VJS	JMM3	JMM3	4/16/15	ISSUED FOR REVIEW

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

PRINTED NAME ____

SIGNATURE ____

DATE ____ LICENSE # ____

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT	4/16	5/08	5/13				
BID							
CONSTRUCTION							

DATE RELEASED

BARR

Corporate Headquarters: Minneapolis, Minnesota
Ph: 1-800-632-2277

Project Office:
BARR ENGINEERING CO.
3128 14TH AVENUE EAST
HIBBING, MN 55746
Ph: 1-800-225-1966
Fax: (218) 262-3460
www.barr.com

Scale	AS SHOWN
Date	03/10/15
Drawn	VJS
Checked	JMM3
Designed	VJS
Approved	JMM3

MINNTAC
MOUNTAIN IRON, MINNESOTA

MINNTAC TAILING BASIN
WEST SEEPAGE COLLECTION

OPTION 1 – CATCHMENT 1
COLLECT/PUMP BACK – MIN WETLAND IMPACT

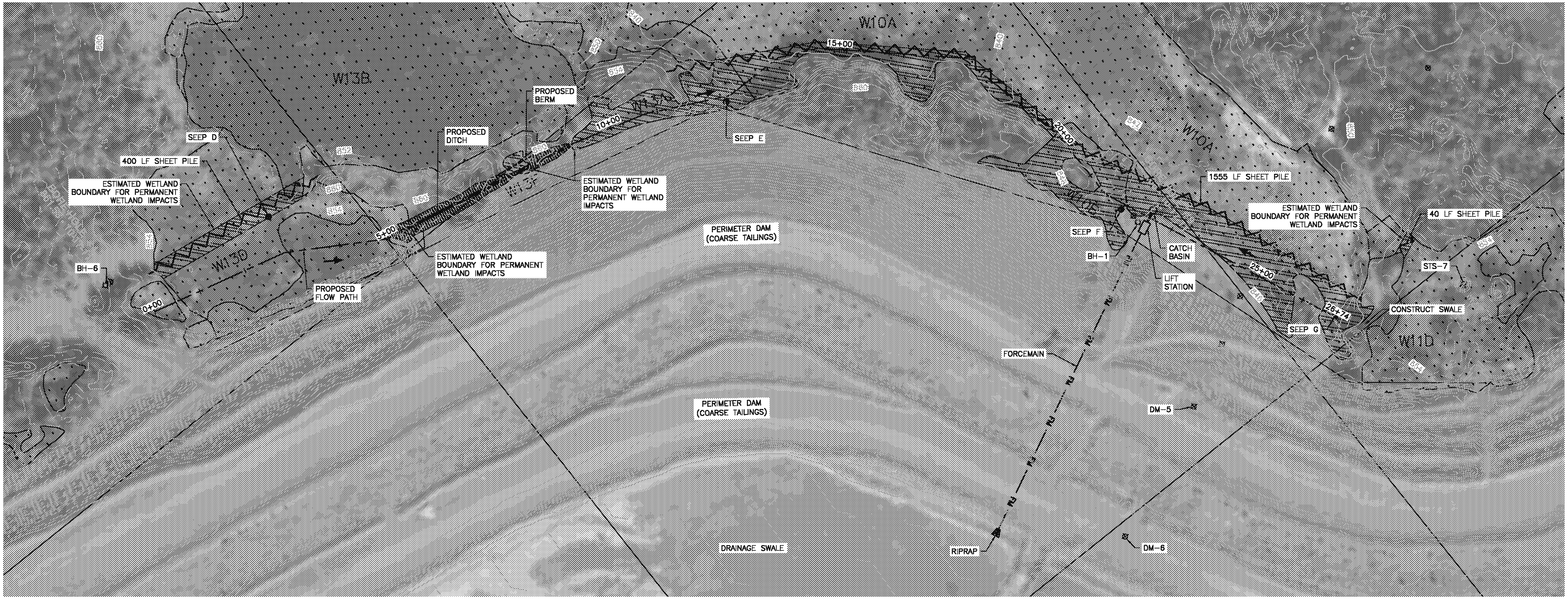
BARR PROJECT No. 23/69-1607

CLIENT PROJECT No.

DWG. No. FIG 1B

REV. No. C

CADD USER: Veronica Sackett FILE: M:\DESIGN\23691607.00\23691607.00_FIGURE 1B.DWG PLOT SCALE: 1:2 PLOT DATE: 5/13/2015 9:16 AM
BAR M:\AutoCAD 2011\AutoCAD 2011 Support\cmu\Template\Barr_2011_Template.dwt Plot ct 1 10/05/2010 14:03:50



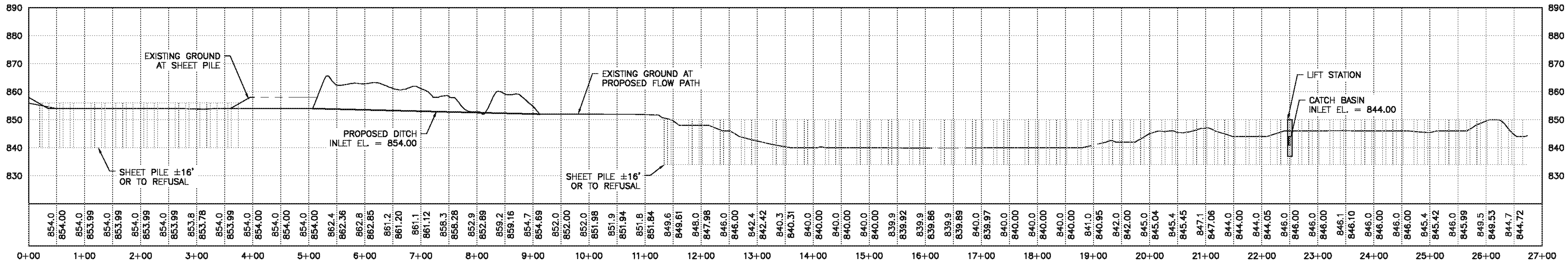
LEGEND

PROPOSED SHEET PILE
FM — PROPOSED FORCEMAIN
WETLAND IMPACT AREA

0 100 200
SCALE IN FEET

PERMANENT WETLAND IMPACTS = 3.15 ACRES
TEMPORARY FOR CONSTRUCTION = 0.00 ACRES

NOTES:
1. WETLAND BOUNDARIES ARE PER DELINEATIONS PROVIDED BY MINNTAC FROM 2014 DELINEATION REPORT
2. SUBSURFACE GEOTECHNICAL INFORMATION PROVIDED BY MINNTAC FROM HISTORICAL RECORDS
3. TOPOGRAPHY PROVIDED BY MINNTAC



0 100 200
SCALE IN FEET
HORIZONTAL

0 20 40
SCALE IN FEET
VERTICAL

ISSUED FOR REVIEW

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION
C	VJS	JMM3	JMM3	5/13/15	ISSUED FOR REVIEW-UPDATED WITH WETLAND ID NUMBERS
B	VJS	JMM3	JMM3	5/08/15	ISSUED FOR REVIEW-UPDATED PER MINNTAC COMMENTS
A	VJS	JMM3	JMM3	4/16/15	ISSUED FOR REVIEW

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
PRINTED NAME ______
SIGNATURE ______
DATE ______ LICENSE # ______

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT	4/16	5/08	5/13				
BID							
CONSTRUCTION							
	DATE RELEASED						

BARR
Corporate Headquarters: Minneapolis, Minnesota Ph: 1-800-632-2277

Project Office:
BARR ENGINEERING CO.
3128 14TH AVENUE EAST
HIBBING, MN 55746
Ph: 1-800-225-1966
Fax: (218) 262-3460
www.barr.com

Scale	AS SHOWN
Date	03/10/15
Drawn	VJS
Checked	JMM3
Designed	VJS
Approved	JMM3

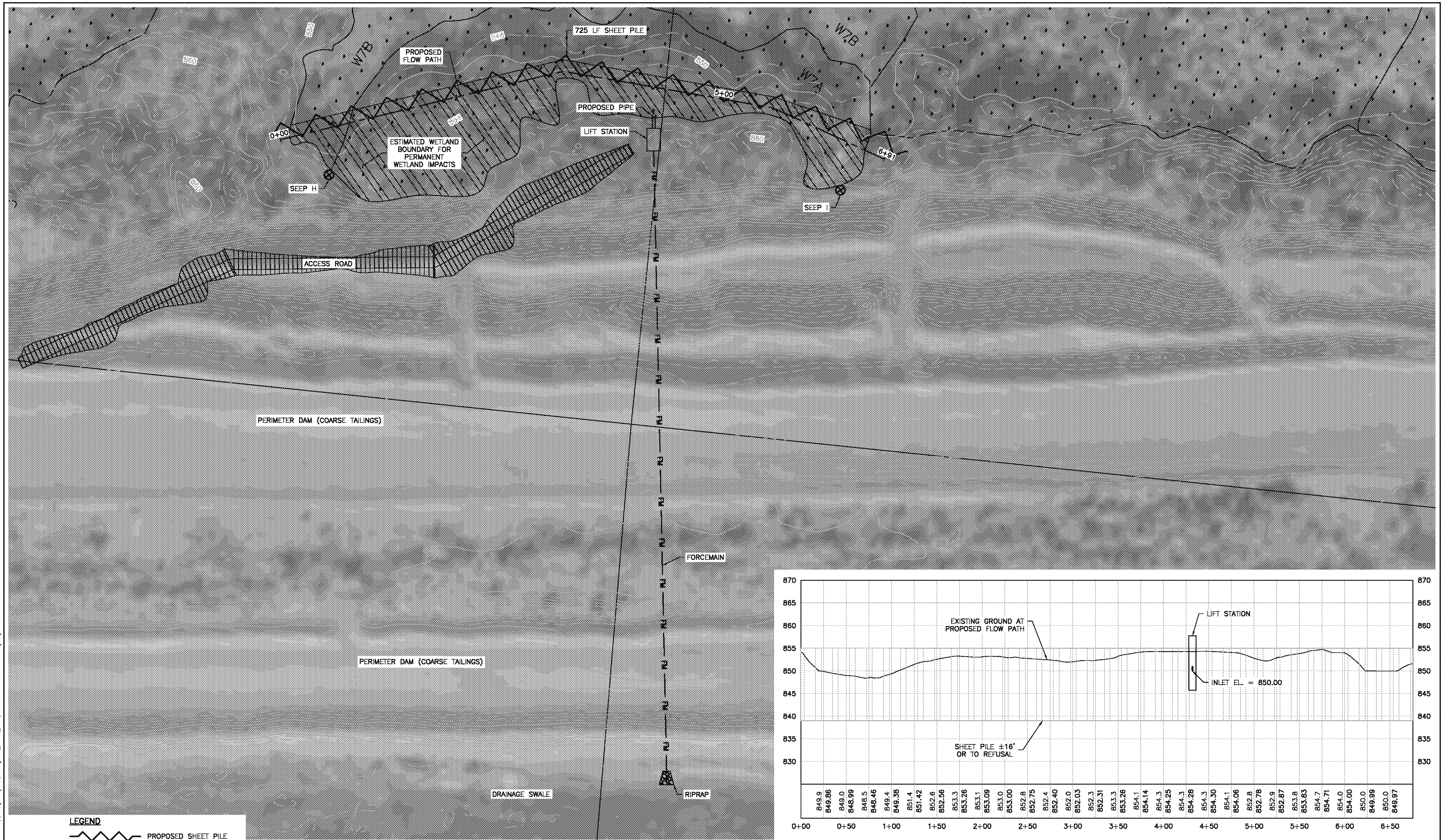
MINNTAC
MOUNTAIN IRON, MINNESOTA

MINNTAC TAILING BASIN
WEST SEEPAGE COLLECTION

OPTION 1 - CATCHMENT 2
COLLECT/PUMP BACK - MIN WETLAND IMPACT

BARR PROJECT No. 23/69-1607
CLIENT PROJECT No.
DWG. No. FIG 2
REV. No. C

CADD USER: Veronica Sackett FILE: M:\DESIGN\23691607.00\2369160700_FIGURE 2.DWG PLOT SCALE: 1:2 PLOT DATE: 5/13/2015 9:32 AM
BARR M:\AutoCAD 2011\AutoCAD 2011 Support\enu\Template\Barr_2011_Template.dwt Plot ct 1 10/05/2010 14:03:50



LEGEND

- PROPOSED SHEET PILE
- FM — PROPOSED FORCEMAIN
- WETLAND IMPACT AREA

0 50 100
SCALE IN FEET

PERMANENT WETLAND IMPACTS = 0.95 ACRES
TEMPORARY FOR CONSTRUCTION = 0.00 ACRES

NOTES:
1. WETLAND BOUNDARIES ARE PER DELINEATIONS PROVIDED BY MINNTAC FROM 2014 DELINEATION REPORT
2. SUBSURFACE GEOTECHNICAL INFORMATION PROVIDED BY MINNTAC FROM HISTORICAL RECORDS
3. TOPOGRAPHY PROVIDED BY MINNTAC

0 50 100
SCALE IN FEET
HORIZONTAL

0 10 20
SCALE IN FEET
VERTICAL

ISSUED FOR REVIEW

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION
C	VJS	JMM3	JMM3	5/13/15	ISSUED FOR REVIEW-UPDATED WITH WETLAND ID NUMBERS
B	VJS	JMM3	JMM3	5/08/15	ISSUED FOR REVIEW-UPDATED PER MINNTAC COMMENTS
A	VJS	JMM3	JMM3	4/16/15	ISSUED FOR REVIEW

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
PRINTED NAME ____
SIGNATURE ____
DATE ____ LICENSE # ____

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT	4/16	5/08	5/13				
BID							
CONSTRUCTION							
	DATE RELEASED						

BARR
Corporate Headquarters: Minneapolis, Minnesota
Ph: 1-800-632-2277
Project Office:
BARR ENGINEERING CO.
3128 14TH AVENUE EAST
HIBBING, MN 55746
Ph: 1-800-225-1966
Fax: (218) 262-3460
www.barr.com

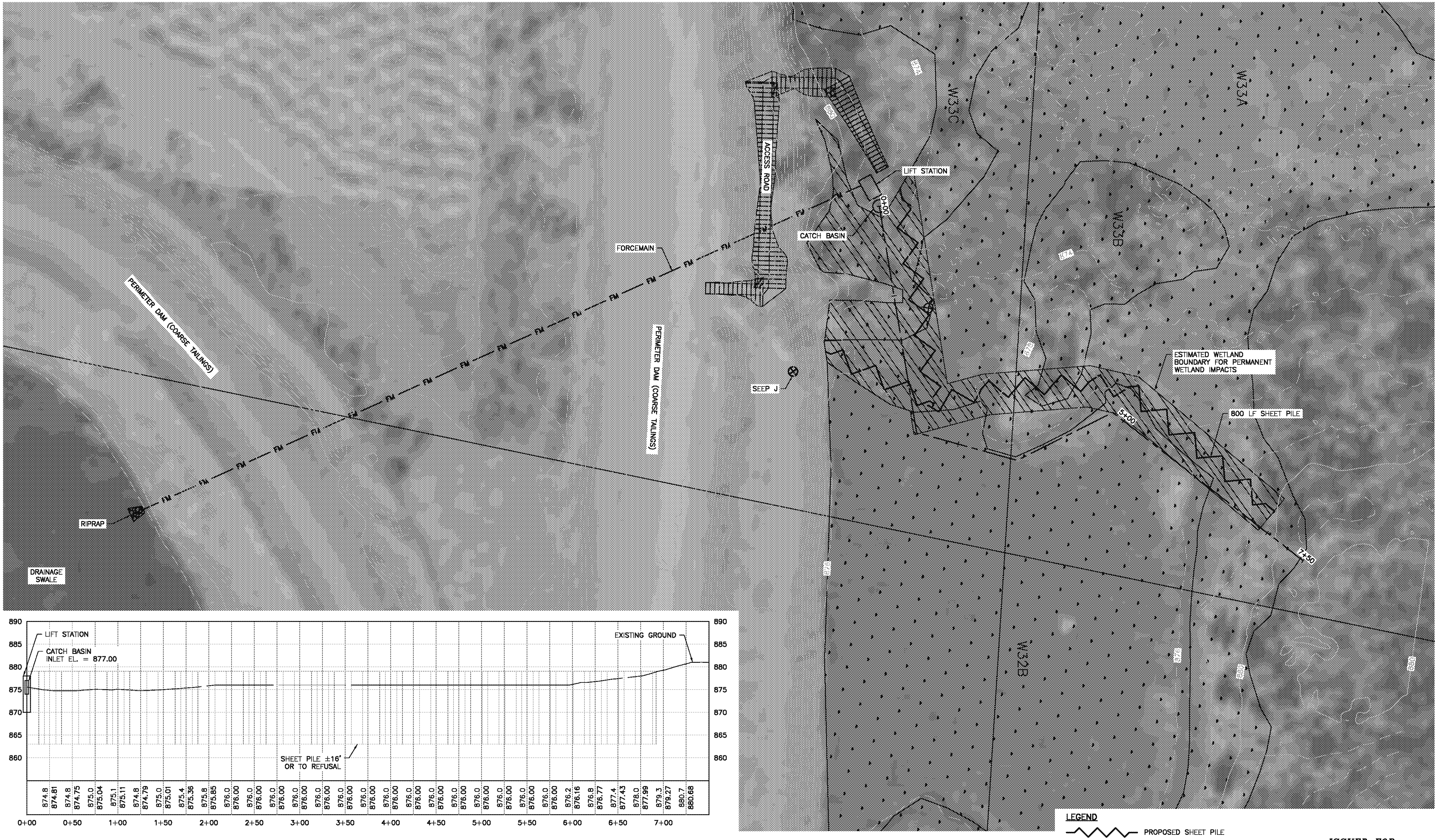
Scale	AS SHOWN
Date	03/10/15
Drawn	VJS
Checked	JMM3
Designed	VJS
Approved	JMM3

MINNTAC
MOUNTAIN IRON, MINNESOTA

MINNTAC TAILING BASIN
WEST SEEPAGE COLLECTION
OPTION 1 - CATCHMENT 3
COLLECT/PUMP BACK - MIN WETLAND IMPACT

BARR PROJECT No. 23/69-1607
CLIENT PROJECT No.
DWG. No. FIG 3
REV. No. C

CADD USER: Veronica Sackett FILE: M:\DESIGN\23691607.00\23691607.00_FIGURE 3.DWG PLOT SCALE: 1:2 PLOT DATE: 5/13/2015 9:36 AM



PERMANENT WETLAND IMPACTS = 1.05 ACRES

TEMPORARY FOR CONSTRUCTION = 0.00 ACRES

0 50 100
SCALE IN FEET
HORIZONTAL

0 10 20
SCALE IN FEET
VERTICAL

NOTES:
1. WETLAND BOUNDARIES ARE PER DELINEATIONS PROVIDED BY MINNTAC FROM 2014 DELINEATION REPORT
2. SUBSURFACE GEOTECHNICAL INFORMATION PROVIDED BY MINNTAC FROM HISTORICAL RECORDS
3. TOPOGRAPHY PROVIDED BY MINNTAC

0 50 100
SCALE IN FEET

LEGEND

PROPOSED SHEET PILE

FM — PROPOSED FORCEMAIN

WETLAND IMPACT AREA

ISSUED FOR REVIEW

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION
C	VJS	JMM3	JMM3	5/13/15	ISSUED FOR REVIEW-UPDATED WITH WETLAND ID NUMBERS
B	VJS	JMM3	JMM3	5/08/15	ISSUED FOR REVIEW-UPDATED PER MINNTAC COMMENTS
A	VJS	JMM3	JMM3	4/16/15	ISSUED FOR REVIEW

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

PRINTED NAME

SIGNATURE

DATE LICENSE #

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT	4/16	5/08	5/13				
BID							
CONSTRUCTION							

DATE RELEASED

BARR

Corporate Headquarters: Minneapolis, Minnesota Ph: 1-800-632-2277

Project Office:
BARR ENGINEERING CO.
3128 14TH AVENUE EAST
HIBBING, MN 55746
Ph: 1-800-225-1966
Fax: (218) 262-3460
www.barr.com

Scale	AS SHOWN
Date	04/03/15
Drawn	VJS
Checked	JMM3
Designed	VJS
Approved	JMM3

MINNTAC
MOUNTAIN IRON, MINNESOTA

MINNTAC TAILING BASIN
WEST SEEPAGE COLLECTION

OPTION 1 - CATCHMENT 4
COLLECT/PUMP BACK - MIN WETLAND IMPACT

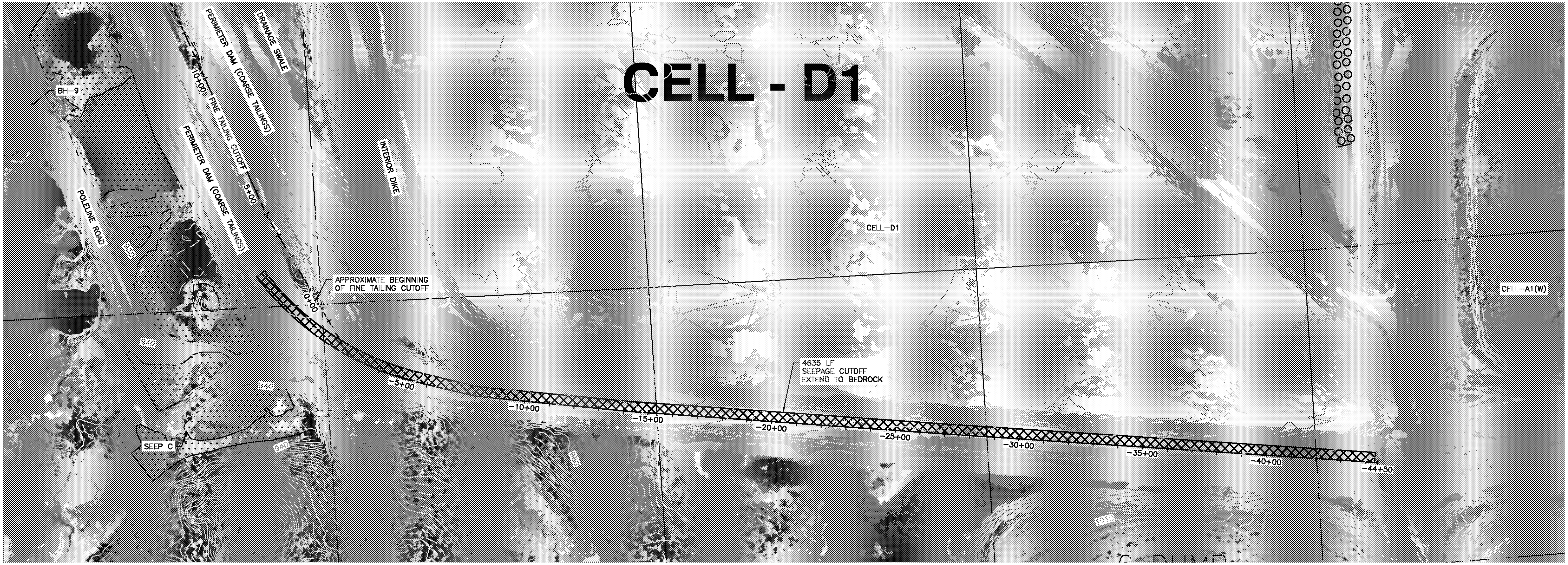
BARR PROJECT No. 23/69-1607

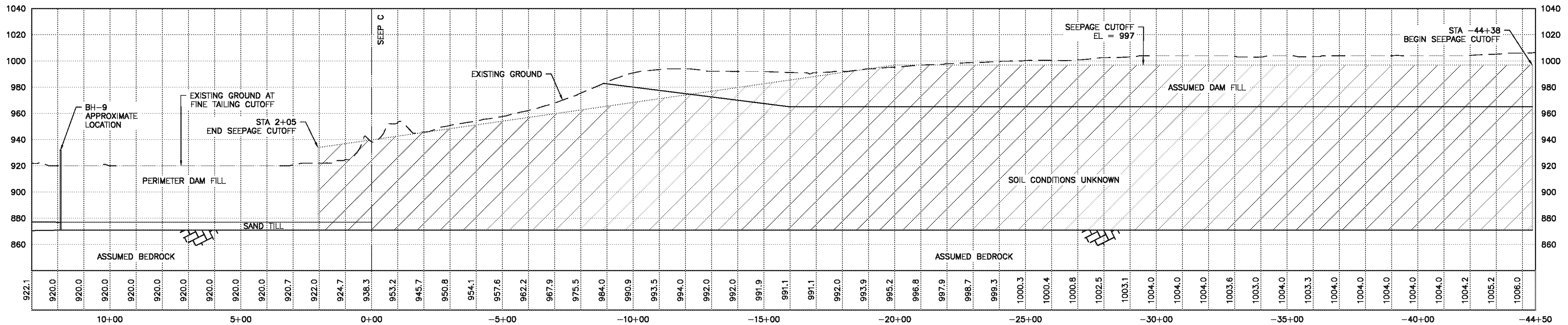
CLIENT PROJECT No.

DWG. No. FIG 4

REV. No. C

CADD USER: Veronica Sackett FILE: M:\DESIGN\23691607.00\2369160700_FIGURE 4B.DWG PLOT SCALE: 1:2 PLOT DATE: 5/13/2015 9:40 AM





0 200 400
SCALE IN FEET
HORIZONTAL

0 40 80
SCALE IN FEET
VERTICAL

NOTES:
1. WETLAND BOUNDARIES ARE PER DELINEATIONS PROVIDED BY MINNTAC FROM 2014 DELINEATION REPORT
2. SUBSURFACE GEOTECHNICAL INFORMATION PROVIDED BY MINNTAC FROM HISTORICAL RECORDS
3. TOPOGRAPHY PROVIDED BY MINNTAC

ISSUED FOR REVIEW

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION
A	VJS	JMM3	JMM3	4/16/15	ISSUED FOR REVIEW

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

PRINTED NAME
SIGNATURE
DATE LICENSE #

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT	4/16						
BID							
CONSTRUCTION							

DATE RELEASED

BARR
Corporate Headquarters: Minneapolis, Minnesota
Ph: 1-800-632-2277

Project Office:
BARR ENGINEERING CO.
3128 14TH AVENUE EAST
HIBBING, MN 55746
Ph: 1-800-225-1966
Fax: (218) 262-3460
www.barr.com

Scale	AS SHOWN
Date	03/13/15
Drawn	VJS
Checked	JMM3
Designed	VJS
Approved	JMM3

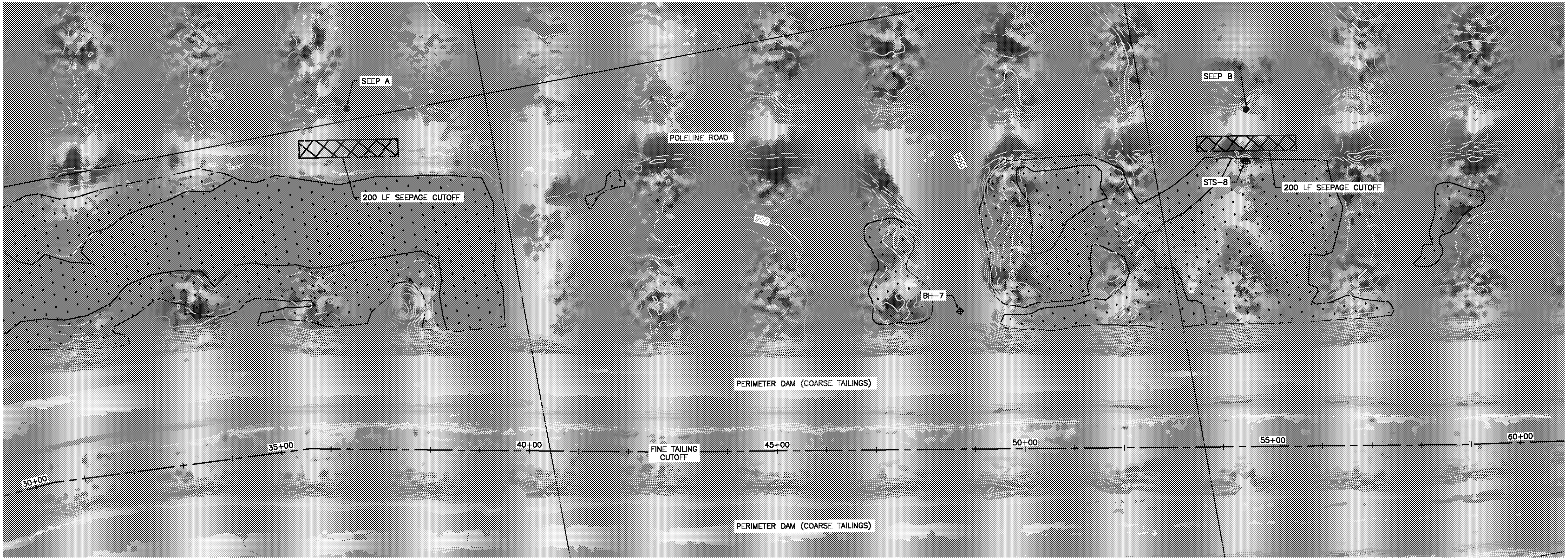
MINNTAC
MOUNTAIN IRON, MINNESOTA

MINNTAC TAILING BASIN
WEST SEEPAGE COLLECTION

OPTION 2
SEEPAGE CUTOFF – NO WETLAND IMPACT

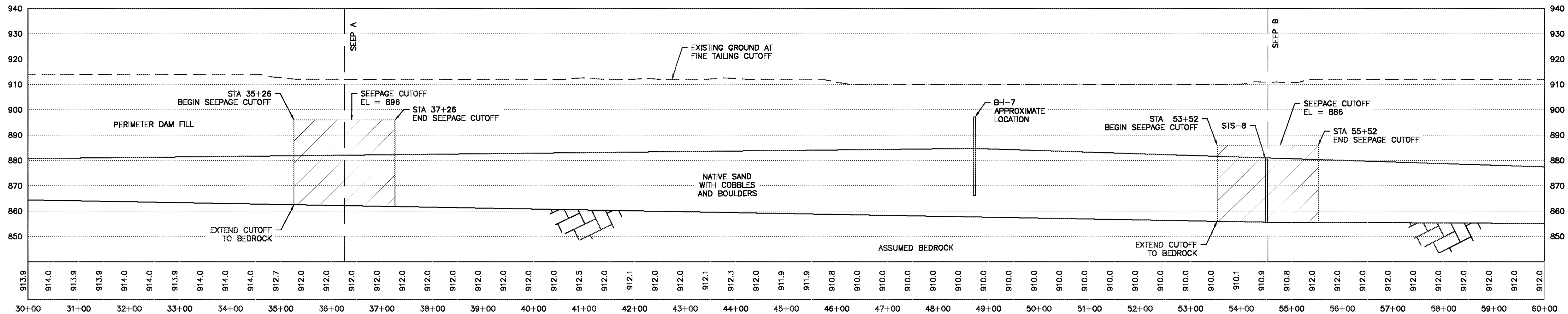
BARR PROJECT No. 23/69-1607
CLIENT PROJECT No.
DWG. No. FIG 5
REV. No. A

CADD USER: Veronica Sackett FILE: M:\DESIGN\23691607.00\2369160700_FIGURE 5.DWG PLOT SCALE: 1:2 PLOT DATE: 5/8/2015 10:05 AM
BAR M:\AutoCAD 2011\AutoCAD 2011 Support\enu\Template\Barr_2011_Template.dwt Plot at 1 10/05/2010 14:03:50



0 100 200
SCALE IN FEET

NOTES:
1. WETLAND BOUNDARIES ARE PER DELINEATIONS PROVIDED BY MINNTAC FROM 2014 DELINEATION REPORT
2. SUBSURFACE GEOTECHNICAL INFORMATION PROVIDED BY MINNTAC FROM HISTORICAL RECORDS
3. TOPOGRAPHY PROVIDED BY MINNTAC



0 100 200
SCALE IN FEET
HORIZONTAL

0 20 40
SCALE IN FEET
VERTICAL

ISSUED FOR REVIEW

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION
A	VJS	JMM3	JMM3	4/16/15	ISSUED FOR REVIEW

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
PRINTED NAME ____
SIGNATURE ____
DATE ____ LICENSE # ____

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT	4/16						
BID							
CONSTRUCTION							
	DATE RELEASED						

BARR
Corporate Headquarters: Minneapolis, Minnesota Ph: 1-800-632-2277

Project Office:
BARR ENGINEERING CO.
3128 14TH AVENUE EAST
HIBBING, MN 55746
Ph: 1-800-225-1966
Fax: (218) 262-3460
www.barr.com

Scale	AS SHOWN
Date	03/13/15
Drawn	VJS
Checked	JMM3
Designed	VJS
Approved	JMM3

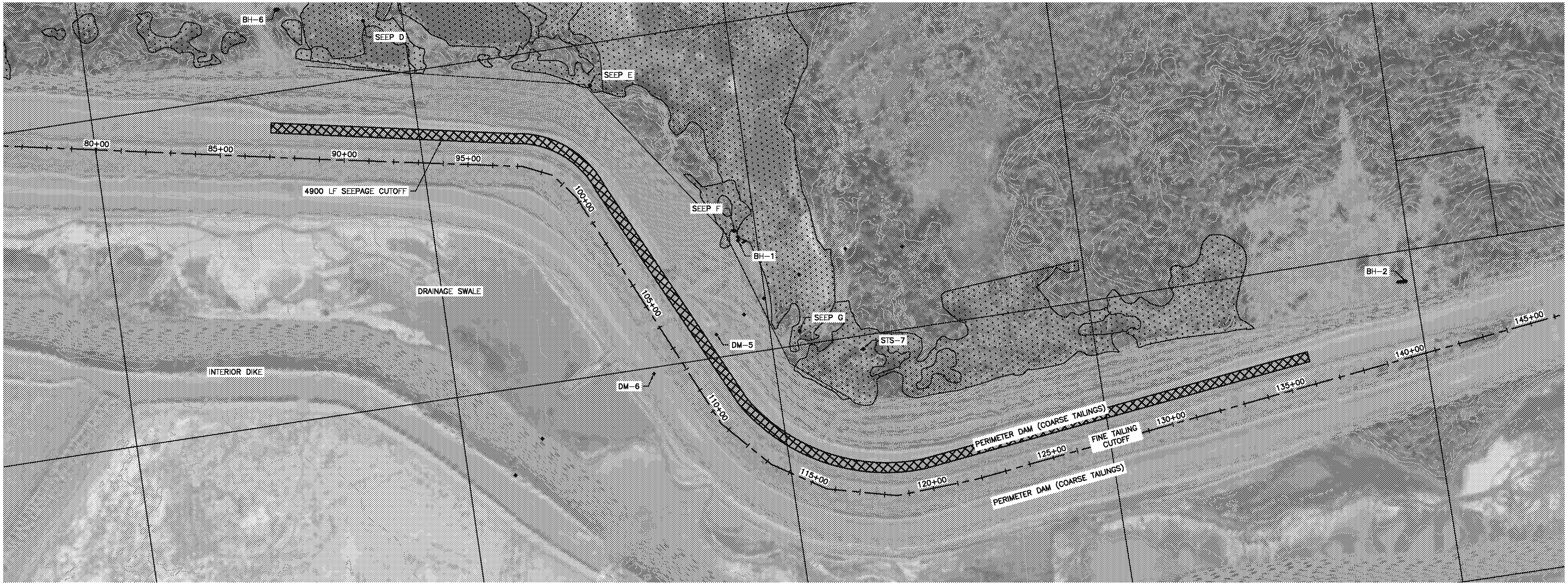
MINNTAC
MOUNTAIN IRON, MINNESOTA

MINNTAC TAILING BASIN
WEST SEEPAGE COLLECTION
OPTION 2
SEEPAGE CUTOFF – NO WETLAND IMPACT

BARR PROJECT No. 23/69-1607
CLIENT PROJECT No.
DWG. No. FIG 6
REV. No. A

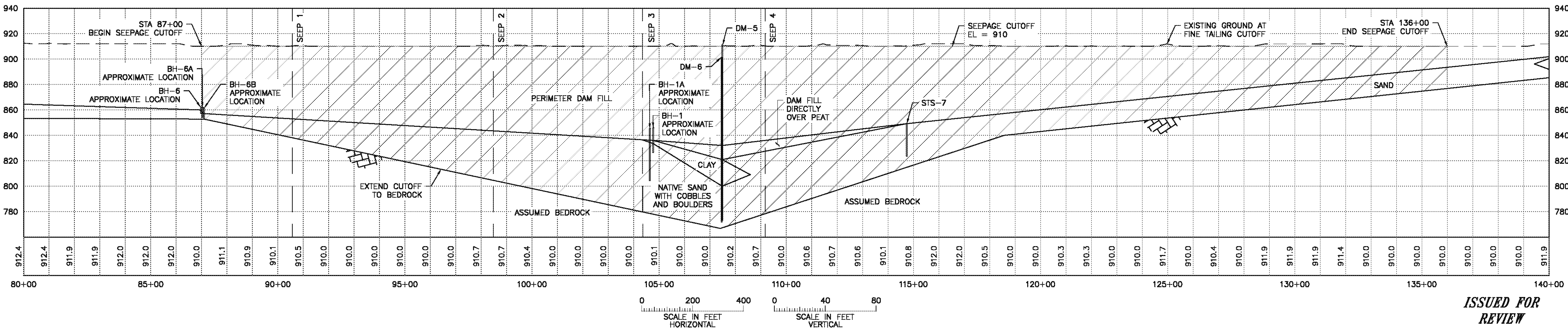
CADD USER: Veronica Sackett FILE: M:\DESIGN\23691607.00\2369160700_FIGURE 6.DWG PLOT SCALE: 1:2 PLOT DATE: 5/8/2015 10:08 AM
BARR M:\AutoCAD 2011\AutoCAD 2011 Support\enu\Template\Barr_2011_Template.dwt Plot ct 1 10/05/2010 14:03:50

ED_005586A_00005293-00018



0 200 400
SCALE IN FEET

NOTES:
1. WETLAND BOUNDARIES ARE PER DELINEATIONS PROVIDED BY MINNTAC FROM 2014 DELINEATION REPORT
2. SUBSURFACE GEOTECHNICAL INFORMATION PROVIDED BY MINNTAC FROM HISTORICAL RECORDS
3. TOPOGRAPHY PROVIDED BY MINNTAC



ISSUED FOR REVIEW

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION
A	VJS	JMM3	JMM3	4/16/15	ISSUED FOR REVIEW

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.

PRINTED NAME ____

SIGNATURE ____

DATE ____ LICENSE # ____

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT	4/16						
BID							
CONSTRUCTION							
	DATE RELEASED						

BARR

Project Office:
BARR ENGINEERING CO.
3128 14TH AVENUE EAST
HIBBING, MN 55746
Ph: 1-800-225-1966
Fax: (218) 262-3460
www.barr.com

Corporate Headquarters:
Minneapolis, Minnesota
Ph: 1-800-632-2277

Scale	AS SHOWN
Date	03/13/15
Drawn	VJS
Checked	JMM3
Designed	VJS
Approved	JMM3

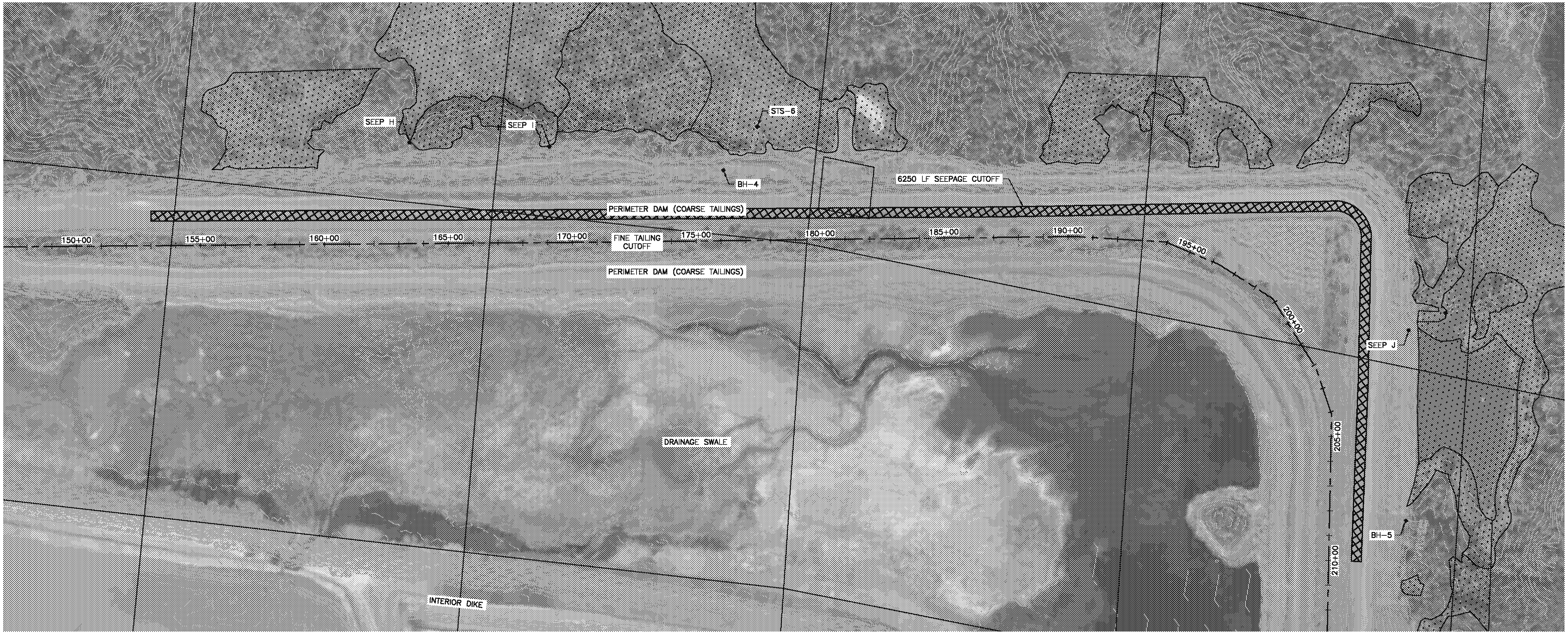
MINNTAC
MOUNTAIN IRON, MINNESOTA

MINNTAC TAILING BASIN
WEST SEEPAGE COLLECTION

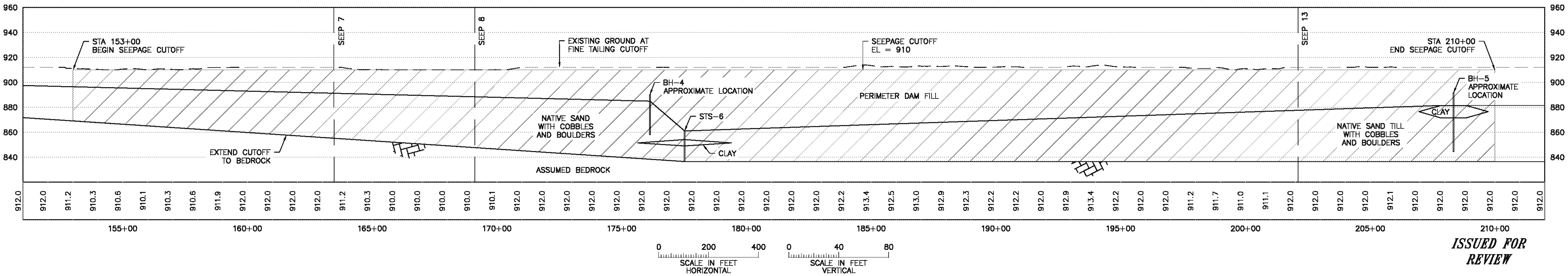
OPTION 2
SEEPAGE CUTOFF – NO WETLAND IMPACT

BARR PROJECT No. 23/69-1607
CLIENT PROJECT No.
DWG. No. FIG 7
REV. No. A

CADD USER: Veronica Sackett FILE: M:\DESIGN\23691607.00\23691607000_FIGURE 7.DWG PLOT SCALE: 1:2 PLOT DATE: 5/8/2015 10:13 AM
BAR M:\AutoCAD 2011\AutoCAD 2011 Support\enu\Template\Barr_2011_Template.dwt Plot at 1 10/05/2010 14:03:50



NOTES:
1. WETLAND BOUNDARIES ARE PER DELINEATIONS PROVIDED BY MINNTAC FROM 2014 DELINEATION REPORT
2. SUBSURFACE GEOTECHNICAL INFORMATION PROVIDED BY MINNTAC FROM HISTORICAL RECORDS
3. TOPOGRAPHY PROVIDED BY MINNTAC



ISSUED FOR REVIEW

CADD USER: Veronica Sackett FILE: M:\DESIGN\23691607.00\23691607.00_FIGURE 8.DWG PLOT SCALE: 1:2 PLOT DATE: 5/8/2015 10:16 AM
BARR M:\AutoCAD 2011\AutoCAD 2011 Support\enu\Template\Barr_2011_Template.dwt Plot ct 1 10/05/2010 14:03:50

NO.	BY	CHK.	APP.	DATE	REVISION DESCRIPTION
A	VJS	JMM3	JMM3	4/16/15	ISSUED FOR REVIEW

I HEREBY CERTIFY THAT THIS PLAN, SPECIFICATION, OR REPORT WAS PREPARED BY ME OR UNDER MY DIRECT SUPERVISION AND THAT I AM A DULY LICENSED PROFESSIONAL ENGINEER UNDER THE LAWS OF THE STATE OF MINNESOTA.
PRINTED NAME
SIGNATURE
DATE ______ LICENSE # ______

RELEASED TO/FOR	A	B	C	0	1	2	3
CLIENT	4/16						
BID							
CONSTRUCTION							
	DATE RELEASED						

BARR
Corporate Headquarters: Minneapolis, Minnesota Ph: 1-800-632-2277

Project Office:
BARR ENGINEERING CO.
3128 14TH AVENUE EAST
HIBBING, MN 55746
Ph: 1-800-225-1966
Fax: (218) 262-3460
www.barr.com

Scale	AS SHOWN
Date	03/13/15
Drawn	VJS
Checked	JMM3
Designed	VJS
Approved	JMM3

MINNTAC
MOUNTAIN IRON, MINNESOTA

MINNTAC TAILING BASIN
WEST SEEPAGE COLLECTION
OPTION 2
SEEPAGE CUTOFF – NO WETLAND IMPACT

BARR PROJECT No. 23/69-1607
CLIENT PROJECT No.
DWG. No. FIG 8
REV. No. A

ED_005586A_00005293-00020